SATURDAY, JUNE 02, 2007

A Coffee Can Foundry... (making bronze, part 3)

This is Part 3 of my mini-saga on attempting to make home-made bronze, using a method similar to Bronze Age technology. Parts 1 and 2 can be found here:

Part 1: Goal, building and initial tests

Part 2: First attempts at metal melting

Improving the foundry

The main purpose of a foundry furnace is of course to reach the temperature needed to melt the metal or alloy in question. In part 2 I showed that the coffee can foundry (well, paint can foundry) was unable to melt copper (coins).

And so I set out to improving the thermal performance of the furnace by means of the following modifications:

1. Use a Perlite/fire cement refractory lid to bounce some of the radiation loss back into the furnace.
2. Start to fire the furnace in a semi-continuous way, by adding charcoal every 3 - 5 minutes.

Here's the furnace with lid during firing:

In addition I made a new, smaller and much safer crucible by chopping off

the bottom of a disused "SodaStream" (remember those?) carbon dioxide canister. It has a capacity of 50 ml, an inner diameter of 45 mm, a wall thickness of 3 mm and weighs about 190 g (see pic below). This should last a few firings, unlike the "soup can crucibles"!

I first got a bit of practice by empty firing the new crucible, lifting it out periodically and adding fuel when needed. Not a big problem, just rather finicky due to the small size of the furnace cavity.

Next I tried a 30 g charge of clean aluminium. That melted quickly in about 10 - 15 minutes of firing. Passivation was still a problem though: I didn't flux that time. I got the melt out with the usual difficulty caused by the aluminium oxide "skin" and was left with a crucible full of dross! So I returned it to the furnace and added quite a bit of LoSo salt (a 50/50 mixture of sodium and potassium chloride, NaCl/KCl). That melted almost instantly into a very mobile liquid and on adding more it just sank and melted away immediately. I cast it (it splatters a lot!) and ended up with quite a clean crucible.

The Perlite/fire cement refractory material held up well but did sustain a little fire-damage at the top: the exhaust flow is awesome at the estimated 5 - 6 kW power output. Due to the heat generated, the modest incoming cold air flow is isobarically expanded by a factor of almost 4!

Another melt (see pic below) of 32.6 g mixed aluminium (some clean and some scraps) with 16.3 g of LoSo added melted in about the same time, with the fused salt mix clearly floating on top of the aluminium melt. Adding more pieces of scarp aluminium and forcing them in the melt with a dipping tool caused these to fuse immediately into the melt, as ice chips do in hot water. Here's that melt, the black LoSo flux floating neatly on top:

Then I had a little mishap: a fairly large cold blob of melted flux (LoSo) had stuck to the dipping tool and when I stirred the mix one last time the cold salt dropped in, cooling the melt considerably. The resulting cast was small but clean, with a lot of "cold" salt and metal left behind in the crucible. Elbow grease for cleaning that one up! Lesson: allow molten LoSo to rejoin the melt from the dipping tool and remove any cold LoSo prior to using it again...

So, I'm pretty sure I've boosted the temperature by quite a bit but still didn't know by how much...

Next I fired up again to try and melt a small (7.5 g) piece of what I believe to be "yellow brass". It was once part of the "SodaStream" dispensing valve. I've no idea of the composition of this alloy but I'm fairly sure that it's brass: yellow coloured and non-magnetic. I fired it for about 40 minutes and it didn't put a dent in it! That the alloy contained copper was clear: part of it coloured a bright red, probably from cuprous oxide formation.

Conclusions so far...

The improved furnace probably does fire at slightly higher temperature, judging by speed of reaching aluminium melting point and easy of melting salt. The molten salt was very mobile while before it was rather gooey.

The single brass melting test may not have been very conclusive but it seems likely only about 850 C (1560 F) has been reached and not the 900 - 950 C (1650 - 1740 F). This could be problematic for reaching the final goal of the project: to *fuse together copper and tin from copper oxide and tin oxide-carbon reductions*. I'm not even sure what temperature is needed to get these reactions going but I bet I'm a little borderline right now.

So, another attempt at improving the furnace will be made soon. I will fill the paint can to the rim (thereby gaining another 5 mm in height) and make the surface of the top of the furnace completely smooth so that the smooth moulded lid leaves less daylight and "seals" the furnace better.

Another improvement can be made by better controlling the size of the charcoal. Due to the small size of the furnace, I need to break up the BBQ briquettes. I should take more care in getting about 1 cm^3 sized pieces and sift off the fines, to pack the furnace with a maximum fuel punch...

Update:

Following a tip at this forum thread, I decided to play around with the airflow a little. I had previously reduced the airflow a lot and believed it to be more or less optimal. But the furnace was spewing out rather massive amounts of very hot air, definitely increasing the heat loss of the furnace. As all furnaces are essentially "heat pumps", to reach the highest temperature

possible you need not only to generate as much heat as possible but also to retain as much of it as is achievable.

And so I ran a quick test to see if reduced airflow could increase furnace temperature. It would appear to be the case: with the reduced airflow the furnace melted a standard aluminium/LoSo charge in record time.

Then I attempted to melt that dastardly piece of "unknown brass" again, this time using some molten LoSo as heat transfer agent. *Again, no joy!*

Getting the balance between the amount of charcoal and the amount of air right is the crucial part here... that much I have learnt. More charcoal will only generate *more heat if it has enough oxygen*. But *too much air means you're blowing heat out of the furnace*. It's probably a more "delicate" balance for a smaller furnace.

Another poster at said forum suggested boosting heat output by squirting lighter fluid (in my case methanol) directly into the truyère, making it act as a carburettor. I'll try that but it does kind of corrupt the purpose of a "charcoal fired furnace".

Now the race is on to make the above mentioned improvements and work more on the balance between charcoal and air...

The next instalment of this story can be found here.

posted by Gert @ 1:40 PM 11 comments

11 Comments:

At 6:04 PM, Emmanuel said...

Home-made bronze? I once tried to make home-made C-4. I had a blast.

(For any Patriot Act FBI bots scanning the net - I'm just kidding!!!)

At 7:55 PM, Gert said...

C4? Nah, that's a hoot... (lol)

At 4:57 PM, Eitan Ha'ahzari said...

Gert: I'm still speechless. How and when did you learn how to carry out these experiences!? I must say I really respect that. I, myself, have no knowledge in the field of chemistry whatsoever. I remember the courses I had to suffer through in high school and can't stop myself from shedding a tear;)

At 7:56 PM, Gert said...

Well, thanks, *but you ain't seen nuttin' yet...*

At 2:52 PM, The Sentinel said...

Wow, it must be non-stop fun at your household, I'll bet the neighbours climb over themselves to see your foundry and you have to beat people away from your door at the weekend with a shitty stick.

At 2:57 PM, Gert said...

Nope. But those who have seen it thought it was really interesting. And will get *a lot more interesting* soon...

You on the other hand should stick to finding the roots of "your race"...

At 3:30 PM, The Sentinel said...

A lot more interesting?

Come your just playing with us now!

How could you possibly top a coffe can foundry?

At 3:38 PM, Gert said...

You should really learn to spell, you know?

At 3:42 PM, The Sentinel said...

Come on, don't hold back over one missing 'e', tell us that the fun won't end. We need to know.

At 4:22 PM, Gert said...

Well, let me put your ill-founded fears to rest: the fun won't end soon and you'll know about it.

Must be a relief but I'm good like that (lol).

At 9:19 PM, Eitan Ha'ahzari said...

the sentinel trying to cozy up to Gert

Must be a headache being a complete asshole and an intellectual wannabe at the same time.

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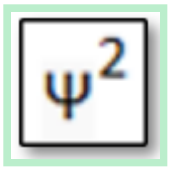

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Born to Annoy: Liberals, Conservatives and RINOs alike!

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